

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1-6. (canceled).

7. (withdrawn): A method forming for a wiring comprising the steps of:
forming a polycrystalline Cu film;
forming, on the polycrystalline Cu film, a layer made of an additional element to be added into the Cu film; and
diffusing the additional element from the additional element layer into the polycrystalline Cu film.

8. (withdrawn): The method for forming a wiring as set forth in Claim 7, wherein a heating step of heating a substrate on which said polycrystalline Cu film has been formed, said step of forming the additional element layer, and said step of diffusing the additional element are simultaneously performed.

9. (withdrawn): The forming method for wiring as set forth in Claim 7 or 8, wherein the additional element is at least one element selected from a group consisting of Ti, Zr, Hf, Cr, Co, Al, Sn, Ni, Mg, and Ag.

10. (withdrawn): A method for manufacturing a semiconductor device comprising the steps of:

forming a polycrystalline Cu film on a substrate on which a semiconductor element is formed;

forming a layer composed of an additional element on the polycrystalline Cu film; and
diffusing the additional element from the additional element layer into the polycrystalline Cu film.

11. (withdrawn): A method for manufacturing a semiconductor device comprising the steps of:

forming an insulating film on a substrate on which a semiconductor element has been formed;

forming concavities for wiring composed of at least either grooves or holes in the insulating film;

forming a Cu film on the insulating film so as to fill up the concavities for wiring;

removing an excessive Cu film on the insulating film excluding parts buried in the concavities for wiring by chemical mechanical polishing;

forming a layer composed of an additional element on the Cu film;

diffusing the additional element from the additional element layer into the Cu film; and

removing an excessive additional element layer.

12. (withdrawn): A method for manufacturing a semiconductor device comprising the steps of:

forming an insulating film on a substrate on which a semiconductor element has been formed;

forming concavities for wiring composed of at least either grooves or holes in the insulating film;

forming a barrier metal film to prevent Cu from diffusing on the surface of the insulating film including inner surfaces of the concavities for wiring;

forming a Cu film on the insulating film so as to fill up the same in the concavities for wiring;

removing a Cu film and a barrier metal film on the insulating film excluding parts buried in the concavities for wiring by chemical mechanical polishing;

forming a layer composed of an additional element on the Cu film in the concavities for wiring;

diffusing the additional element from the additional element layer into the Cu film; and
removing an excessive additional element layer.

13. (withdrawn): The method for manufacturing a semiconductor device as set forth in Claim 11 or 12, wherein

said step of forming the additional element layer, said step of diffusing the additional element, and said step of removing the excessive additional element layer are performed before said step of removing the excessive Cu film.

14. (withdrawn): The method for manufacturing a semiconductor device as set forth in Claim 11 or 12, wherein

said step of forming the additional element layer, said step of diffusing the additional element, and said step of removing the excessive additional element layer are performed after said step of removing the excessive Cu film.

15. (withdrawn): The method for manufacturing a semiconductor device as set forth in any one of Claims 10, 11 or 12, wherein

a step of heating the substrate, said step of forming the additional element layer, and said step of diffusing the additional element are simultaneously performed.

16. (withdrawn): The method for manufacturing a semiconductor device as set forth in any one of Claims 10, 11 or 12, wherein

the additional element is at least one element selected from a group consisting of Ti, Zr, Hf, Cr, Co, Al, Sn, Ni, Mg, and Ag.

17. (currently amended): A copper alloy for wiring formed by a manufacturing method comprising the steps of:

forming a polycrystalline Cu film;

forming, on the polycrystalline Cu film, a layer made of an additional element to be added into the polycrystalline Cu film;

diffusing the additional element from the additional element layer into the polycrystalline Cu film via crystal grain boundaries to form a polycrystalline copper alloy; and

simultaneously therewith performing gettering of oxygen in the polycrystalline Cu film into the additional element layer, wherein

the additional element is at least one element selected from a group consisting of Ti (titanium), Zr (zirconium), Hf (hafnium), Cr (chromium), Co (cobalt), Al (aluminum), Ni (nickel), and Mg (magnesium), and

concentration of the additional element is, at grain boundaries of crystal grains composing the polycrystalline copper alloy and in vicinities of grain boundaries, higher than that of the inside of the crystal grains, a barrier ~~layer-metal film containing a barrier metal~~ is formed to surround the polycrystalline copper alloy, and concentration of the additional element is, at the interface between the polycrystalline copper alloy and the barrier ~~layer-metal film~~ and in vicinities of said interface, higher than that of the inside of the crystal grains, and

a ~~the barrier metal at the interface between~~ in the barrier metal film ~~and the polycrystalline copper alloy~~ has not been oxidized.

18. (currently amended): A copper alloy for wiring formed by a manufacturing method comprising the steps of:

forming a polycrystalline Cu film;

forming, on the polycrystalline Cu film, a layer made of an additional element to be added into the polycrystalline Cu film;

diffusing the additional element from the additional element layer into the polycrystalline Cu film via crystal grain boundaries to form a polycrystalline copper alloy; and

simultaneously therewith performing gettering of oxygen in the polycrystalline Cu film into the additional element layer, wherein

the additional element is at least one element selected from a group consisting of Ti (titanium), Zr (zirconium), Hf (hafnium), Cr (chromium), Co (cobalt), Al (aluminum), Sn (tin), Ni (nickel), and Mg (magnesium), and

concentration of the additional element is, at grain boundaries of crystal grains composing the polycrystalline copper alloy and in vicinities of grain boundaries, higher than that of the inside of the crystal grains, and

an oxide of the additional element is formed at said grain boundaries and/or in vicinities of said grain boundaries, and

a barrier metal ~~at the interface between~~in a barrier metal film ~~and the polycrystalline copper alloy~~ has not been oxidized.

19. (currently amended): A copper alloy for wiring formed by a manufacturing method comprising the steps of:

forming a polycrystalline Cu film;

forming, on the polycrystalline Cu film, a layer made of an additional element to be added into the polycrystalline Cu film;

diffusing the additional element from the additional element layer into the polycrystalline Cu film via crystal grain boundaries to form a polycrystalline copper alloy; and

simultaneously therewith performing gettering of oxygen in the polycrystalline Cu film into the additional element layer, wherein

the additional element is at least one element selected from a group consisting of Ti (titanium), Zr (zirconium), Hf (hafnium), Cr (chromium), Co (cobalt), Al (aluminum), Ni (nickel), and Mg (magnesium), and

concentration of the additional element is, at grain boundaries of crystal grains composing the polycrystalline copper alloy and in vicinities of grain boundaries, higher than that of the inside of the crystal grains, and concentration of the additional element in the crystal grains is 0.1 atomic percent or less, and

a barrier metal ~~at the interface between~~in a barrier metal film ~~and the polycrystalline copper alloy~~ has not been oxidized.

20. (canceled).

21. (previously presented): The copper alloy for wiring as set forth in Claim 19, wherein at the crystal grain boundaries and/or in the vicinities of grain boundaries, intermetallic compounds of Cu and at least one element selected from a group consisting of Ti, Zr, Hf, Cr, Co, Al, Ni, and Mg are formed.

22. (previously presented): The copper alloy for wiring as set forth in Claim 19, wherein at the crystal grain boundaries and/or in the vicinities of grain boundaries, oxides of at least one element selected from a group consisting of Ti, Zr, Hf, Cr, Co, Al, Ni, and Mg are formed.

23. (previously presented): A semiconductor device comprising a substrate on which a semiconductor element is formed, and a metal wiring composed of the copper alloy for wiring as set forth in any one of Claims 17, 18, 19, 21 or 22.

24. (previously presented): The copper alloy for wiring as set forth in any one of Claims 18, 19, 21 or 22, wherein

concentration of the additional element at the grain boundaries and in the vicinities of grain boundaries is on the order of 2 to 1000 times the additional element concentration at the inside of the crystal grains.

25. (previously presented): The copper alloy for wiring as set forth in Claim 19, wherein concentration of the additional element at the grain boundaries and in the vicinities of grain boundaries is on the order of 10 to 100 times the additional element concentration at the inside of the crystal grains.